Determination of Ciprofloxacin Hydrochloride by a Flow Injection Chemiluminescence inhibition method

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Abstract: On the basis of Ce (IV) and rhodamine B obvious light signal under the acid medium, the Ce(IV)-rhaodamine B-H_2SO_4 hemiluminescence system was established. In this paper, the ciprofloxacin hydrodchloride under the concentration of less than 1.0×10^{-5} g/mL was explored, and a new determination of ciprofloxacin hydrochloride by using flow injection chemiluminescence inhibition was established. Under the best experimental conditions, the relationgship of the chemiluminescence reduced value ΔI with the concentration of ciproflocacin haydrochloride in 6.0×10^{-7}~8.0×10^{-6} g/mL was linear within a detection limit of 2.0×10^{-7}g/mL. the relative standard deviation is 2.0% by 11 parallel determinations of ciprofloxacin hydrochloride which the concentration is 5.0×10^{-6} g/mL .

Introduction

Ciprofloxacin Hydrochloride (CIP) is the third generation synthetic fluoroquinolones' drug. This kind of drugs exhibits high activity against a broad variety of bacteria with high antibacterial activity, low toxicity and completely orally absorption, which has been widely used in clinic medicine and in preventing and curing aquatic livestock bacteriosis. Capillary Electrophoresis[1, 2], High performance liquid chromatography (HPLC)[3,4], Spectrophotometry[5] and Flow-injection chemiluminescence[6] have been used for determination of this kind of drugs. The Flow-injection chemiluminescence has the advantages of simple equipment, easy operation and high sensitivity. In this paper, the chemical luminescence behavior of Rhodamine B and Ciprofloxacin hydrochloride in sulfuric acid medium with cerium (IV) has been studied, and the new determination of ciprofloxacin hydrochloride by using Flow injection chemiluminescence was established.

Experimental

Apparatus and Reagents

Apparatus

Flow injection chemiluminescence analyzer (IFFM-E type, Xi'an Rui Mai electronic technology Co., LTD.).

Reagents

Rhodamine B (Tianjin Damao Chemical reagent factory); Ammonium ceric sulfate (Chinese medicine (group) company Shanghai chemical reagent);

Ciprofloxacin hydrochloride stock solution (1.0mg/mL): 50 mg reference substance of Ciprofloxacin hydrochloride was Accurately weighed in 50mL volumetric flask, and was diluted to the required concentration by distilled water;

Rhodamine B stock solution (1.0mmol/L): 0.0239g reference substance of Rhodamine B was Accurately weighed in 50mL volumetric flask, and was diluted to the required concentration by 0.10 mol/L H_2SO_4;

Ammonium ceric sulfate stock solution (20mmol/L): 1. 0965 g$(NH_4)_2Ce(NO_3)_2$ was prepared to 100 mL 20.0 mmol /L Ammonium ceric sulfate stock solution by20mL 1.0mol/L H_2S0_4, and was diluted to the required concentration by 0.10 mol/L H_2SO_4.

The reagents above are analysis pure, The water that used in this study is distilled water.

Procedure

In the flow system, the sample solution was mixed with Rhodamine B solution in the tee. When the fluid was flowed steady, the mixture would be flowed through the injector and mixed with cerium(IV) solution to the flow cell, and made the chemiluminescence. The chemiluminescence intensity was detected, and quantified by relative Chemiluminescence, which shown schematically in Fig. 1. As the blank luminescence signal is I_0 and the sample luminescence signal is I_S, the relative Chemiluminescence is ΔI ($\Delta I_0 = I_S - I_0$).

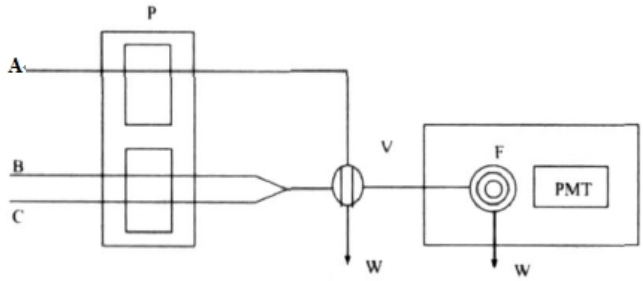

Fig 1 Schematic description of flow injection chemiluminescence system.
P: peristaltic pump; V: injector; F: flow cell; PMT: photomultiplier tube;
W: waste liquid; A:Ammonium ceric sulfate solution;
B:sample solution; C:Rhodamine B solution

Instrument flow parameters

In these instrument flow parameters, high voltage 1000 v; rejector cutoff frequency 50 hz; the 1st, 3rd, 5th, 7th steps: Main pump speed 35 r/min, deputy pump speed 20 r/min, running time 10s, valve positionR; the 2nd, 4th, 6th, 8th steps: Main pump speed 40 r/min, deputy pump speed 0 r/min, running time 30s, valve position L.

Results and Discussion

Kinetic curves of chemiluminescence

The chemiluminescence of the Ce(IV) - rhaodamine B - H_2SO_4 system could be strongly inhibited under the selected experimental conditions.

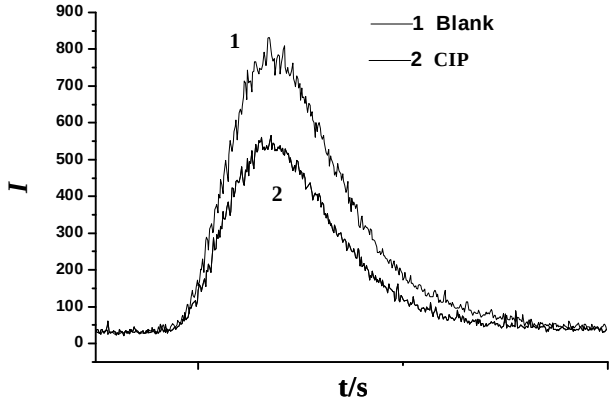

Fig 2 Kinetic curves of chemiluminescence
C(Cip):10.0×μg/mL;
C(Rhodamine B):0. 02 mmol /L; C(Ce(IV)):2.0mmol/L

The selection of chemiluminescence experimental conditions

The influence of H_2SO_4 concentration

The chemiluminescence of the Ce(IV) - rhaodamine B - H_2SO_4 system could be significant influenced by the concentration of the acid. H_2SO_4 was used as the acid medium and the relative Chemiluminescence is ΔI wasexamined within the scope of 0.02 to 0.12 mol/L as shown in figure 3. After the experiment, the concentration of H_2SO_4 in 0.10 mol/L was chosen for it made the optimal signal-to-noise ratio.

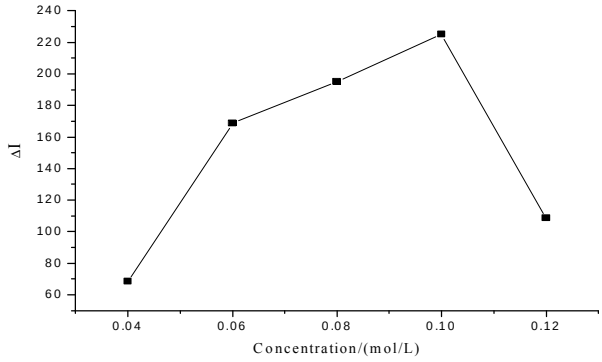

Fig 3 Influence of H_2SO_4 concentration on CL intensity
C(Ciprofloxacin Hydrochloride):10.0 μg/mL；
C(Rhodamine B):0. 02 mmol /L； C(Ce(IV)):2.0mmol/L

The influence of Ce(IV) concentration

The increase rate of ΔI was decreased as the concentration of Ce(IV) rising. In this experiment, the optimal Ce(IV) concentration of 2.0mmol/L was chosen as shown in figure 4.

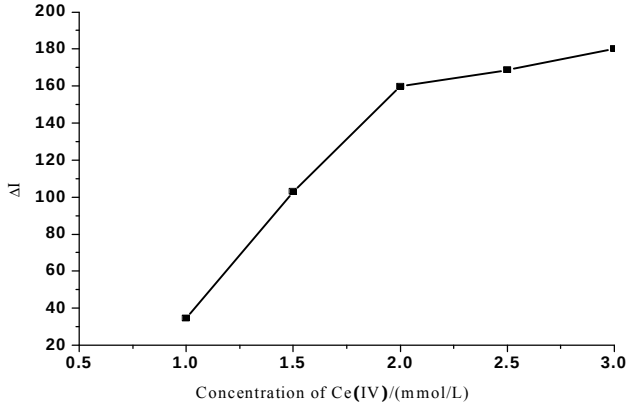

Fig 4 Influence of Ce (IV) concentration on CL intensity
C(Ciprofloxacin Hydrochloride):10.0 μg/mL； C(Rhodamine B):0. 02 mmol/L

The influence of Rhodamine B concentration

Fixed ciprofloxacin hydrochloride and Ce (IV) concentration in a constant, the chemiluminescence intensity was detected as the Rhodamine B concentration changing in a range of 0.005~0.030mmol/L. As shown in figure 4, the optimal concentration of Rhodamine B is 0.025 mmol/L.

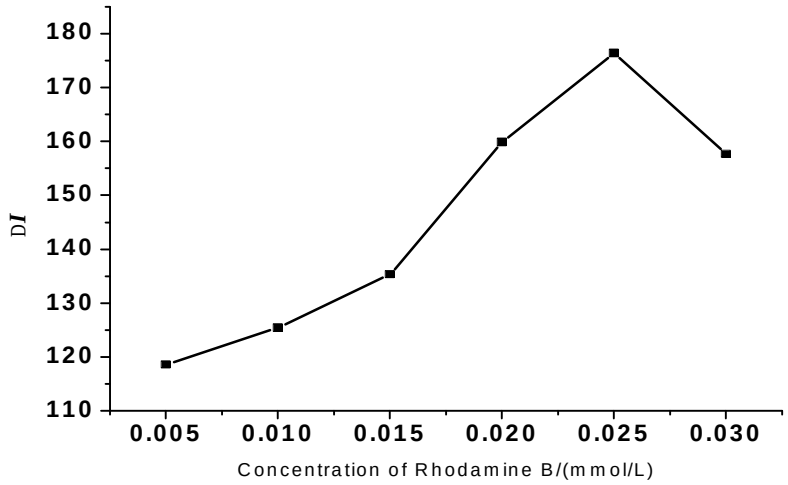

Fig 5 Influence of Rhodamine B concentrate on CL intensity
C(Ciprofloxacin Hydrochloride):10.0 μg/mL； C(Ce(IV)):2.0mmol/L

The influence of interfering substance concentration

The influence of common metal ions and excipients which in the human body to the luminous intensity was detected. As the experimental results showed, the chemiluminescence would not be interferenced by at least 1000 times of Cd^{2+}; 500 times of Cl^-; 1000 times of Na^+;150 times of Al^{3+} Zn^{2+},$C_2O_4^{2-}$； 100 times of glucose, starch, Ca^{2+},Cu^{2+},Mg^{2+}； 50 times of citric acid,Mn^{2+},Fe^{3+}. But it could be interferenced by 10 times of Fe^{2+} and I^-.

Working curve, Accuracy and Limit of detection

Under the optimum experimental conditions, luminescence intensity reveals a good linear relationship for the Ciprofloxacin Hydrochloride concentration at the range of 6.0×10^{-7}～8.0×10^{-6} g/mL, and the linear regression equation is: ΔI= 1.20*10^7 C +34.1 (the unit is g·mL^{-1}*10^{-6}), r=0.9986. Based on 11 measurements of blank solution, detection limit (3σ) of 1.0×10^{-9}g/mL was obtained. Relative standard deviation (RSD) of 2.0% was obtained based on 11 measurements for a 5.0×10^{-6} g/mL CIP solution. The limit of detection (LOD) of 2.0 x 10-7 g/mL was obtained according to the IUPAC.

The sample analysis

Ten ciprofloxacin capsules were grinded, and the powder was weighed out in the proper amount accurately, and 0.004 mol/L NaOH was added to dissolve it, and then the solution would be filtered and diluted to 50 mL. 5 pieces of ciprofloxacin eye drops were dealed in the same way. The sample solution was then diluted to proper volume and determined the amount of ciprofloxacin under the optimized conditions by using the working curve method. The results is showed as table 1

Tab 1 The CIP content and recovery of samples

Samples	Labeled amount /mg	Measured amount /mg	uv spectrometry /mg	Added recovery /%	Average recoveries /%
Capsule	200	203.8	202.8	99.7 103.5 99.6 104.2	101.8
Eye drops	15	14.9	15.1	101.2 102.5 102.4 102.8	102.2

Acknowledgements

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